AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A method for yielding transient solutions for a film-blowing process by using a film-blowing process model ~~wherein~~ which comprises continuously extruding a polymer melt ~~is continuously extruded,~~ in the presence of air, through an annular die, in both an axial and circumferential direction, simultaneously, said axial direction being produced by the axial extension imposed by the drawing force of nip rolls and the circumferential direction being produced by the air pressure inside the extended polymer melt ~~whereby~~ to produce a biaxially oriented film, ~~is produced~~ wherein the following governing equations concerning the viscoelasticity and cooling characteristics of the film are first solved; and ~~then,~~ then changing, through coordinate transformation, a free-end-point problem ~~is changed~~ into a fixed-end-point problem; and finally, [[by]] introducing Newton's method and OCFE (Orthogonal Collocation on Finite ~~Elements),~~ Elements to obtain the transient solution for the film blowing process ~~is obtained~~:

Equations:

$$\frac{\partial}{\partial t}\left(rw\sqrt{1+\left(\frac{\partial r}{\partial z}\right)^2}\right)+\frac{\partial}{\partial z}(rwv)=0, \qquad (1)$$

Where,

$$t=\frac{\bar{t}\bar{v}_0}{\bar{r}_0},\quad z=\frac{\bar{z}}{\bar{r}_0},\quad r=\frac{\bar{r}}{\bar{r}_0},\quad v=\frac{\bar{v}}{\bar{v}_0},\quad w=\frac{\bar{w}}{\bar{w}_0}$$

Axial direction:

$$\frac{2rw[(\tau_{11}-\tau_{22})]+2r\sigma_{surf}}{\sqrt{1+(\partial r/\partial z)^2}}+B(r_F^2-r^2)-$$
$$2C_{gr}\int_0^{2_L} rw\sqrt{1+(\partial r/\partial z)^2}\,dz-2\int_0^{2_L} r\,T_{drag}d_z=T_z$$

(2)

Where,

$$T_z=\frac{\overline{T_z}}{2\pi\eta_0\overline{w_0}\,\overline{v_0}},\quad B=\frac{\overline{r_0^2}\,\Delta P}{2\eta_0\overline{w_0}\,\overline{v_0}},$$

$$\Delta P=\frac{A}{\int_0^{zL}\pi\overline{r}^2\,d\overline{z}}-P_a,\quad \tau_{ij}=\frac{\overline{\tau_{ij}}\,\overline{r_0}}{2\eta_0\overline{v_0}}$$

$$C_{gr}=\frac{\rho g\overline{r_0^2}}{2\eta_0\overline{v_0}},T_{drag}=\frac{\overline{T_{drag}}\,\overline{r_0^2}}{2\eta_0\overline{v_0}\,\overline{w_0}};\sigma_{surf}=\frac{\overline{\sigma_{surf}\,r_0}}{2\eta_0\overline{v_0}\,\overline{w_0}}$$

Circumferential direction:

$$B=\left(\frac{\left[-w\left(\tau_{11}-\tau_{22}\right)+2\sigma_{surf}\right]\left(\partial^2 r/\partial z^2\right)}{\left[1+\left(\partial r/\partial z\right)^2\right]^{3/2}}+\frac{w\left(\tau_{33}-\tau_{22}\right)+2\sigma_{surf}}{\tau\sqrt{1+\left(\partial r/\partial z\right)^2}}-C_{gr}\frac{\partial r/\partial z}{\sqrt{1+\left(\partial r/\partial z\right)^2}}\right) \tag{3}$$

Constitutive Equation:

$$K\boldsymbol{\tau}+De\left(\frac{\partial\boldsymbol{\tau}}{\partial t}+\boldsymbol{v}\cdot\nabla\boldsymbol{\tau}-\boldsymbol{L}\cdot\boldsymbol{\tau}-\boldsymbol{\tau}\cdot\boldsymbol{L}^{\mathrm{T}}\right)=2\frac{De}{De_0}\boldsymbol{D}, \tag{4}$$

where $K=\exp[\varepsilon\, De\, \mathrm{tr}\, \boldsymbol{\tau}]$, $\boldsymbol{L}=\nabla\boldsymbol{v}-\xi\boldsymbol{D}$, $2\boldsymbol{D}=(\nabla\nu+\nabla\boldsymbol{v}\mathrm{T})$, $De_0=\frac{\lambda\bar{\boldsymbol{v}}_0}{r_0}$, $De=De_0\,\exp\left[k\left(\frac{1}{\theta}-1\right)\right]$.

Energy Equation:

$$\frac{\partial\theta}{\partial t}+\frac{\nu}{\sqrt{1+(\partial r/\partial z)^2}}\frac{\partial\theta}{\partial z}+\frac{U}{w}(\theta-\theta_c)+\frac{E}{w}(\theta^4-\theta_\infty^4)=0, \tag{5}$$

Where,

$$\theta = \frac{\bar{\theta}}{\bar{\theta}_0}, \quad \theta_c = \frac{\bar{\theta}_c}{\bar{\theta}_0}, \quad \theta_\infty = \frac{\bar{\theta}_\infty}{\bar{\theta}_0}, \quad U = \frac{\bar{U}\bar{r}_0}{\rho C_P \bar{w}_0 \bar{v}_0},$$

$$E = \frac{\varepsilon_m \sigma_{SB} \bar{\theta}_0^4 \bar{r}_0}{\rho C_P \bar{w}_0 \bar{v}_0 \bar{\theta}_0}$$

Boundary conditions:

$$v = w = r = \theta = 1, \qquad \tau = \tau_0 \quad \text{at } z = z_0, \tag{6a}$$

$$\frac{\partial r}{\partial t} + \frac{\partial r}{\partial z}\frac{v}{\sqrt{1 + (\partial r/\partial z)^2}} = 0, \qquad \frac{v}{\sqrt{1 + (\partial r/\partial z)^2}} = D_R,$$

$$\theta = \theta_F \quad \text{at } z = z_F. \tag{6b}$$

wherein, r denotes the dimensionless bubble radius, w the dimensionless film thickness, v the dimensionless fluid velocity, t the dimensionless time, z the dimensionless distance coordinate, ΔP the air pressure difference between inside and outside the bubble, B the dimensionless pressure drop, A the air amount inside the bubble, P_a the atmospheric pressure, T_z the dimensionless axial tension, η_o the zero-shear viscosity, C_{gr} the gravity coefficient, T_{drag} the aerodynamic drag, σ_{surf} the surface tension, θ the dimensionless film temperature, τ the dimensionless stress tensor, D the dimensionless strain ~~train~~ rate tensor, ε and ξ the Phan Thien-Tanner (PTT) model parameters, De the Deborah number, θ_0 the zero-shear viscosity, K the dimensionless activation energy, λ the fluid relaxation time, U the dimensionless heat transfer coefficient, E the dimensionless radiation coefficient, k_{air} the thermal conductivity of cooling air,

ρ_{air} the density of cooling air, η_{air} the viscosity of cooling air, v_c dimensionless cooling air velocity , α and β parameters of heat transfer coefficient relation, θ_c the dimensionless cooling-air temperature, θ_∞ the dimensionless ambient temperature, ε_m the emissivity, σ_{SB} the Stefan-Boltzmamn constant, ρ the density, C_p the heat capacity, D_R the drawdown ratio; and wherein

the assumption was made that no deformation occurred in the film past a freezeline at the boundary conditions; overbars denote the dimensional variables; subscripts 0, F and L denote the die exit, the freezeline conditions and the nip roll conditions, respectively; and subscripts 1, 2 and 3 denote the flow direction, normal direction, and circumferential direction, respectively.

2. (Previously Presented) The method for yielding transient solutions for the film-blowing process by using a film-blowing process model according to claim 1, wherein a non-isothermal process model is a numerical scheme for yielding transient solutions for the film-blowing process, which has three multiplicities.

3. (Currently Amended) The method for yielding transient solutions for the film-blowing process by using a film-blowing process model ~~wherein~~ which comprises providing a nonlinear stabilization analysis method of the process ~~is provided that~~ which utilizes the temporal pictures obtained from the numerical scheme [[in]] of Claim 1.

4. (Currently Amended) The method for yielding transient solutions for the film-blowing process by using a film-blowing process model according to claim 1, which comprises optimizing ~~wherein a method is provided for the optimization of~~ the process which is obtained by ~~the use of~~ using a sensitivity analysis of the relative effects affecting the stability of each process variable through a transient solution, which was calculated and yielded in the course of deduction of the transient solutions.

Claim 5 (Cancelled)

6. (Currently Amended) An apparatus for the optimization and stabilization of a film-blowing apparatus utilizing the numerical scheme as defined in claim 1, ~~wherein~~ which comprises

means ~~are provided~~ for introducing a polymer melt and pressurized air through an annular ~~die where it is~~ die,

means for continuously ~~extruded~~ extruding the polymer melt in both an axial and circumferential direction,

~~wherein~~ nip rollers operatively associated with the extruded polymer melt ~~are provided~~ to produce a drawing force for achieving axial extension of the polymer melt, and

[[the]] means for applying pressurized air ~~is utilized~~ to the polymer melt to achieve the expansion of the melt in the circumferential direction, whereby a biaxially oriented film is produced.